× method + residual. The samples used were two sources of alfalfa hay (1 and 2), corn silage (1 and 2), dried distillers grains plus solubles (1 and 2), grain mixes (1 and 2), and TMR (1 and 2), and one source of soybean meal, soybean hulls, whole cottonseed, sunflower seeds, and feces. Six replicates were used for each analysis. With the exception of soybean meal and sunflowers, the NDF content was determined to be greater ($P < 0.05$) in samples analyzed with RA compared to AFA. Acid detergent fiber for alfalfa-1 (30.9 vs. 29.5%), feces (33.2 vs. 31.1%), soybean meal (8.7 vs. 5.9%), soybean hulls (47.0 vs. 45.7%), and TMR-1 (22.3 vs. 20.7%) was greater ($P < 0.05$) when measured with AFA versus RA. In addition, the ADF in alfalfa-1 (32.0 and 28.4%), corn silage-1 (27.8 vs. 25.6%) and 2 (28.0 vs. 26.5%), feces (34.0 vs. 30.3%), grain mix-2 (8.2 vs. 5.4%) soybean meal (9.0 vs. 5.6%), soybean hulls (46.9 vs. 45.8%), and TMR-1 (21.6 vs. 19.8%) and 2 (23.8 vs. 19.2%) was greater ($P < 0.02$) with D versus S. An interaction ($P < 0.05$) between apparatus and method was observed in corn silage-2, soybean meal, and soybean hulls, such that the decrease in ADF from AFAD to AFAS in these samples was much greater compared to the decrease in ADF from RAD to RAS. In conclusion, analysis with RA vs. AFA yielded increased values for NDF in most of the samples analyzed and decreased ADF in some of the samples. Analyzing samples with S decreased ADF in most feeds compared to D.

Key Words: Feed analysis, Feeds, Detergent fiber analysis

W197 A comparison of soluble true protein assays using three precipitating agents and filter pore sizes. D. A. Ross*, J. B. Robertson, and M. E. Van Amburgh, *Cornell University*, *Ithaca, NY*.

Protein in feeds for ruminants is separated into two primary categories based on solubility and the soluble pool is characterized by true protein (TP) versus non-protein nitrogen (NPN). Tungstic acid (TA) is the preferred precipitating (PPT) agent as it chelates smaller peptides than trichloroacetic acid (TCA) but does not filter efficiently. The objective of this study was to improve the efficiency of the TP assay. Two criteria for improvement were identified. The PPT agent needs to chelate smaller peptides and the filtration step requires improvement in recovery of the chelated peptides. Nine feeds (1 alfalfa hay, 1 alfalfa silage, 3 feathermeals, 2 soy products and 2 hay crop silages), rumen fluid and trypticase were analyzed using three PPT agents: TA (Licitra et al., 1996; 16-h; 1.18 % final dilution.), a Stabilized TA (STA; phosphate buffered; 16-h; 1.11 %) and TCA (1-h; 10 %). Three different filters were also evaluated under vacuum for all PPT agents: 20, 6 and 1 um pore size filter papers. For each PPT and filter combination, N was determined for TP recovered on the filter and NPN in the filtrate. All samples were analyzed in duplicate. Results are expressed as percent of sample N recovered as TP or NPN and compared using GLM in SAS and Tukey's method to separate means. Among all filter combinations STA recovered 2.65 % more N in the TP than did TA ($P < 0.0001$) and 4.35 % more N than TCA ($P < 0.0001$). Trypticase, because of the range in peptide size, was considered the negative control and demonstrated the greatest range in precipitable TP values: 0.025, 21.0 and 33.09 % (TCA, TA and STA, respectively; $P < 0.005$). Without trypticase STA recovered 1.7 % more N in the TP than did TCA ($P < 0.0001$). The overall N recovery averaged 97.8 %. The 1 um pore filter recovered 0.5 % more TP than did the 6 um and 1.3 % more than the 20 um ($P < 0.0001$) while the 6 um recovered 0.8 % more TP than the 20 um ($P < 0.003$). In summary, the STA assay using either a 6 or 1 um filter under vacuum is more efficient than the current method.

Key Words: Tungstic acid, Stabilized tungstic acid, TCA

Ruminant Nutrition: Calves & Heifers – Dairy

W198 Rearing of dairy calves Sahiwal × Holstein feeded with Arachis pintoi and sugar cane. J. Avellaneda-Cevallos*[1], P. Cansing-Yépez[1], W. Vera-Benavides[1], O. Montañez-Valdez[2], S. González-Muñoz[3], J. Vargas-Burgos[1], J. Tuarez-Cobeña[1], and R. Vivas-Moreira[1], [1]*Unidad de Investigación Científica y Tecnológica, Facultad de Ciencias Pecuarias, Universidad Técnica Estatal de Quevedo*, *Quevedo, Ecuador*, [2]*Centro Universitario del Sur. Universidad de Guadalajara*, *Guadarajara, México*, [3]*Colegio de Postgraduados*, *Texcoco, México*.

The substitution (0, 25, 50 and 75%) of the DM and the total protein (TP) of a commercial balanced (B) for the foraging peanut (P) (Arachis pintoi) more sugar cane (S) (Saccharum officinarum) was evaluated. It was used 20 Sahiwal x Holstein, veals with weight initial average of 72.5±4 kg. The treatments were: BS, B (100% of the requirement total protein (TPR) in DM) + S; BSP25, 75% of B + P (25% of the TPR in DM) + S; BSP50, 50% of B + P (50% of the TPR in DM) + S; BSP75, 25% of B + P (75% of the TPR in DM) + S. A totally at random experimental design was used. The daily gain of weight (DWG), consumption of DM (DMC), feed conversion (FC), consumption of TP (TPC) and economic analysis was evaluated. Three experimental periods were evaluated (1-30, 31-60 and 61-90 d) and a total (1-90 d). The DWG per period and total (g d-1) were not different ($p>0.05$). In the total period the averages of DWG were 0.587, 0.627, 0.549 and 0.584; for the levels of substitution 0, 25, 50 and 75% of PT, respectively. The DMC in the periods 31-60 d and total was bigger ($p <0.05$) when the diet contained less P. The FC was not affected ($p>0.05$) for the substitution. The TPC in the periods 1-30, 31-60 and total was superior ($p <0.05$) in the treatments with bigger quantity of P. There were better economic profit with BSP75 (223.94 dollars and 74.14% of profitability). It was concluded that the P is a potential source of protein that allows to improve the productive and economic efficiency of ruminant in growth.

Key Words: Arachis pintoi, Substitution, Saccharum officinarum

W199 Effects of applying exogenous, non-starch polysaccharidases to pre-weaning starter diet on performance of Holstein calves. G. R. Ghorbani[1], A. Jafari[1], A. H. Samie[1], and A. Nikkhah*[2], [1]*Isfahan University of Technology*, *Isfahan, Iran*, [2]*University of Manitoba*, *Winnipeg, MB, Canada*.

This study aimed to assess the effect of applying exogenous, non-starch polysaccharidases (ENP) to pre-weaning starter diet on starter intake, nutrient digestibility, and calf growth. Eighteen Holstein calves (9 males and 9 females; 47.9 ± 2.5 BW; mean ± SD) were grouped by sex and monitored for 84 d in a randomized complete block design with repeated measures. One male calf on EB was noticed unhealthy at week-3 and excluded from the trial. Treatments included pre-weaning starters with 1) no enzyme additives (C), 2) enzyme additive A (EA, 0.6 ml/kg DM), and 3) enzyme additive B (EB, 1.9 ml/kg DM). The

respective activity (μmol/ml/min) of exo-cellulase, endo-cellulase, and xylanase were 1437, 788 and 7476 for EA; and 1446, 1350 and 5091 for EB. Both pre- and post-weaning starters contained 56% rolled barley grain, 8 % whole cottonseed, 8% cottonseed meal, 26% soybean meal, and 2% minerals and vitamins supplement (DM basis). Calves were offered milk (10% of BW) twice daily for 49 d. From 49 to 55 d, the daily milk offer was halved and calves were fully weaned at 56 d. No enzyme additives were added to post-weaning diet. Grab fecal samples were taken at 28, 56, and 84 days of age, for two cosecutive days at each sampling. The acid insoluble ash was used as an internal marker to measure nutrient apparent total tract digestibility. Weaning criterion (WC) or the calf age at a daily intake of 680 g starter was estimated using regression equations. Data were analyzed with Proc Mixed of SAS with the best fitted covariance structures. The ENP did not affect the average starter intake, growth rate, and WC. The EA enhanced ($P < 0.05$) the apparent total tract digestibility of NDF and ADF at wk-4, when compared to C. The apparent fiber digestibility at wk-12 was lower in calves on EB than those on EA and C. Overall, the use of ENP in pre-weaning, calf starter did not appear to have a significant impact on calf growth in this study. Future research is warranted using a combination of cell-wall and cell-content polysaccharidases.

Table 1. Effects of exogenous polysaccharidases on nutrient digestibility and calf performance

Item	Treatment (T) C	EA	EB	$SEM_{C,EA}$	SEM_{EB}	Fixed effect, P T	T × Week
Body weight, kg	73.2	69.5	74	2.1	2.3	0.73	0.82
Average daily gain, g	519	508	555	26.7	29.8	0.51	-
Starter intake, g/d	1281	1260	1278	24.9	27.9	0.99	0.25
Weaning criterion, d	40.5	42.5	41.0	0.8	0.9	0.51	-
Dry matter digestibility[1], %	80.3	78.6	79.3	1.0	1.1	0.61	0.29
NDF digestibility, %	63.2[a]	60.5[a]	55.7[b]	1.4	1.6	0.02	0.006

[1]Nutrient digestibility measured at 28, 56, and 84 d of age, for 2 consecutive d at each occasion.

Key Words: Exogenous non-starch polysaccharidases, Dairy calves, Growth

W200 Physical form of starter concentrate for young Holstein calves. G. R. Ghorbani[1], M. Bagheri Varzaneh[1], and A. Nikkhah*[2], [1]*Isfahan University of Technology*, *Isfahan, Iran*, [2]*University of Manitoba*, *Winnipeg, MB, Canada*.

Controversy exists as to optimal physical form or abrasiveness of starter diet for young calves. Our objective was to evaluate starter intake, growth rate, body weight (BW) and weaning criterion (WC) as affected by starter physical form. Sixteen (8 males and 8 females) Holstein calves (20 ± 3 d initial age and 45.6 \plusmn; 2.3 kg BW; mean \plusmn; SE) were grouped by age, gender, and BW; and assigned to either a conventional ground starter (GS) or a commercial pelleted starter (PS) until 10 weeks of age. Calves within each sex assigned randomly to treatments in a repeated measures design. Ground starter was produced by grinding all dietary ingredients using an on-farm hammer mill with a standard screen size of 1 mm. The pellets were produced after grinding of the starter meal, and averaged 11 mm in length and 4.4 mm in diameter. The two starters (21.8% CP, 1.7 Mcal/kg NEg, 2.2 Mcal/kg NEm) were similar in type and inclusion rate of starter ingredients, and were different only in physical form. Both starters contained 34.5% corn grain, 18% barley grain, 34% soybean meal, 6% wheat bran, 2% sugarcane molasses, 2% alfalfa hay, 1.5% zeolite, and 2% minerals and vitamins supplement, on a DM basis. Calves were offered milk by 10% of their BW until 7 weeks of age and by 8% of BW during week 8, and weaned at a BW of 75 kg. The average daily gain, WC or the age at a daily consumption of 680 g starter, and age at 75 kg BW were estimated using polynomial regression equations. Data were analyzed using MIXED procedure of SAS (v. 9.1, 2003) with appropriate covariance structures. The initial BW values were used as a covariate to further control the experimental error for ADG, BW, and starter intake. The weekly starter intake and BW, growth rate, and WC were not significantly altered ($P > 0.30$) by treatments (Table 1). The average daily starter intake, however, tended to be greater ($P < 0.10$) for calves fed PS than for calves fed GS (851 vs. 716 ± 48 g/d). Calves fed both treatments required the same time to attain 75 kg BW. The conventional GS appeared as effective in promoting adequate starter intake and growth rate for early weaning of dairy calves as the commercial PS.

Table 1. Effects of offering ground starter (GS) or pelleted starter (PS) on calf performance

Item	Starter diet GS	PS	SEM	Treatment effect P value
Initial body weight, kg	45.8	45.4	2.3	0.90
Final body weight, kg	78.2	78.8	1.9	0.80
Total body weight gain, kg	32.6	33.2	1.9	0.82
Average daily gain, g	741.3	783.0	37.7	0.45
Starter intake, g/d	716.5	851.6	48.6	0.07
Weaning criterion, d	50.8	47.6	2.5	0.31
Age at 75 kg BW, d	64.3	64.1	2.8	0.95

Key Words: Starter diet, Physical form, Holstein calf

W201 The effect of milk replacer fat source on calf growth and health. T. J. Earleywine*, T. E. Johnson, H. B. Perry, and B. L. Miller, *Land O'Lakes, Inc.*, *Webster City, IA*.

Calf milk replacer fat source was evaluated to determine the effect on performance and scour data when fed to Holstein bull calves. A total of 54 calves with an initial weight of 47.6 kg were randomly assigned according to body weight and blood gamma globulin concentration to three all-milk protein milk replacer treatments: 1) 22% CP / 20% fat from edible lard; 2) 22% CP / 20% fat from edible lard and butterfat (1:1); or 3) 22% CP / 20% from butterfat. Calf milk replacer was fed averaging 775 g per calf, daily. Milk replacers were medicated (28 g neomycin/kg, 14 g oxytetracycline/kg). Calves were individually housed in crates and fed equal amounts 2 times daily at 700 and 1615 hours. No starter was fed during this 28 day trial. Weight gain, feed efficiency, daily scour scores (1-4 score: 1=normal, 2=loose, 3=water separation, 4=3 with severe dehydration) and scour days were calculated weekly for the four week trial period. Calves fed milk replacer containing edible lard had reduced ($P<.05$) incidence and severity of scours. Edible lard is an excellent fat source for milk replacer fed calves.

Table 1. Treatment

Item	1	2	3	C.V.
BW gain, kg	11.11	11.50	10.47	23.46
CMR, DM, kg	21.44	21.58	20.54	5.34
Feed/gain	2.01	1.93	2.88	25.34
Scour score	1.21[a]	1.28[ab]	1.35[b]	14.73
Scour score	1.21[a]	1.28[ab]	1.35[b]	14.73
Scour score	1.21[a]	1.28[ab]	1.35[b]	14.73

[a,b,c] Means within a row differ (P<0.05)

Key Words: Calf, Milk replacer, Fat source

W202 The effect of milk replacer composition on calf growth and health. B. L. Miller*, T. E. Johnson, H. B. Perry, and T. J. Earleywine, *Land O'Lakes, Inc.*, *Webster City, IA*.

The composition of calf milk replacers was evaluated to determine the effect on performance and scour data when fed to Holstein bull calves. A total of 90 calves with an initial weight of 44.5 kg were randomly assigned according to body weight and blood gamma globulin concentration to five milk replacer treatments: 1) 22% CP / 20% Fat all milk protein (positive control); 2) 20% CP / 10% Fat w/ 60% of protein from soy flour (negative control); 3) 22% CP / 20% Fat all milk protein - 3% pectin; 4) 22% CP / 20% Fat all milk protein - 1.1% psyllium; or 5) 22% CP / 20% Fat w/ 50% of protein from protein modified soy flour. Calf milk replacer was fed averaging 775 g per calf, daily. Milk replacers were medicated (28 g neomycin/kg, 14 g oxytetracycline/kg). Calves were individually housed in individual elevated stalls and fed 2 times daily at 700 and 1615 hours. No starter was fed during this 28 day trial. Weight gain, feed efficiency, daily scour scores (1-4 score: 1=normal, 2=loose, 3=water separation, 4=3 with severe dehydration) and scour days were calculated weekly for the seven week trial period. Calves fed psyllium gained more weight (P<.05) and were more efficient (P<.05) than calves fed soy containing milk replacers. Calves fed pectin, psyllium or protein modified soy flour had a reduced (P<.05) scour severity.

Table 1. Treatment

Item	1	2	3	4	5	C.V.
BW gain, kg	14.89[ab]	10.59[c]	14.81[ab]	15.50[a]	13.72[b]	13.66
CMR, DM, kg	21.49[ab]	21.66[a]	21.66[ab]	21.59[ab]	21.22[b]	2.36
Feed/gain	1.46[ab]	2.09[c]	1.49[ab]	1.40[a]	1.60[b]	14.81
Scour score	1.45[b]	1.58[b]	1.27[a]	1.21[a]	1.30[a]	15.05
Scour days	9.13[bc]	11.41[c]	5.38[a]	4.07[a]	6.81[ab]	56.10

[a,b,c] Means within a row differ (P<0.05)

Key Words: Calf, Milk replacer, Psyllium

W203 Short- and medium-term effects of an enhanced-growth feeding program in dairy calves. M. Terré*[1] and A. Bach[1,2], [1]*IRTA-Unitat de Remugants*, *Barcelona, Spain*, [2]*ICREA*, *Barcelona, Spain*.

Seventy-eight female dairy calves (BW 42.9 ± 4.79 kg and age 9.9 ± 4.61 d) were arranged in 2 groups to compare the short- (up to 72 d) and medium-term (up to 212 d) effects of an enhanced (EF) and a conventional (CF) growth feeding programs. After 1 week of adaptation to a milk replacer (MR), the CF calves were fed 4.3 l/d of MR (25% CP and 19% fat) from 1-27 d, and 2.15 l/d from 28-34 d at 11.2% DM, and the EF calves were offered the same MR at 18% DM: 4 l/d from 1-6 d, 6 l/d from 7-13 d, 7 l/d from 14-20 d, 6 l/d from 21-27 d, and 3 l/d from 28 to weaning day at 34 d of study (50 d of age). Individual calf starter (20.7% CP) consumption was recorded daily from the beginning of the study until 58 d of age. Then, calves were placed in groups of 6 and received a TMR (with different composition depending on age) until 212 d of age. Calves were weighed weekly until 72 d of age and bimonthly until they were 212 d old. Serum urea and NEFA concentrations were determined at 23, 37, 51, 58 and 72 d of age. Days on medical treatments were recorded until 72 d of age. Body weight of EF calves was greater (P < 0.01) than that of CF calves at weaning (74.8 vs 70.1 ± 1.57 kg, respectively) and at 212 d of age (224.4 vs 218.8 ± 1.57 kg, respectively). Starter intake was greater (P < 0.001) in CF than in EF calves (1.02 vs 0.55 ± 0.058 kg/d, respectively) during the preweaning period, and TMR consumption tended (P = 0.05) to be greater in CF than in EF calves (2.8 vs 2.5 ± 0.11 kg/d, respectively) from 59 to 72 d of age. Serum urea concentration was greater (P < 0.01) from 37 to 58 d of age in EF than in CF calves, and serum NEFA concentration was greater (P < 0.01) from 51 to 58 d of age in EF than in CF calves. The use of oral rehydratant support tended (P = 0.12) to be greater in EF than CF calves, but the use of medical treatments did not differ. Calves in EF struggled at weaning as suggested by the increase in serum NEFA and urea concentration that week, but at 212 d of age still maintained the advantage in BW over CF calves achieved during the preweaning period.

Key Words: Calves, Growth, Replacer

W204 No effects of daily concentrate intake on ruminal environment in milk fed calves. N. B. Kristensen*, J. Sehested, S. K. Jensen, and M. Vestergaard, *Danish Institute of Agricultural Sciences*, *Tjele, Denmark*.

Eight Holstein calves (44 ± 1 kg BW at birth) implanted with ruminal cannulaes (20 mm ID) at d 7 ± 1 after birth were used to investigate the effects of milk allowance on concentrate intake and ruminal fermentation patterns. Calves were allocated to one of four treatments (3.0, 4.7, 6.4 or 8.1 L skim-milk-based milk-replacer/d; 130 g solids/L milk). All calves had free access to a barley-based starter concentrate (319 g starch/kg), artificially-dried hay, and water. Ruminal samples were collected every 2 h for 24 h at wk 2, 3, 4, and 5. Ruminal pH was measured immediately and ruminal fluid was stabilized with meta-phosphoric acid for later analysis. Concentrate intake was affected by a treatment times wk interaction (P < 0.01). The smallest concentrate intake was found with 6.4 L milk/d (17 g/d in wk 2 increasing to 389 g/d in wk 5) and the greatest concentrate intake was found with 3.0 L milk/d (310 g/d in wk 2 increasing to 1,601 g/d in wk 5 [SEM = 150]). Daily gain from wk 2 to 5 (714 ± 35 g/d) was not affected (P = 0.49) by treatment. The average (5.8 ± 0.1) and the minimum (5.4 ± 0.1) ruminal pH within a sampling period were not affected (P > 0.24) by treatment or wk. Hours/d with ruminal pH below 6.2 (18 ± 2 h/d), 5.8 (14 ± 2 h/d), and 5.4 (6 ± h/d) were not affected (P > 0.18) by treatment or wk. The total VFA concentration was affected by week (P < 0.01) and increased from 71 ± 9 mmol/L in wk 2 to 133 ± 9 mmol/L in wk 5. All data for calves with concentrate intakes above 25 g/d showed no relationship between concentrate intake level and severity of ruminal environment. The implication is that starch-based concentrates in general might be harmful to the juvenile rumen of milk-fed calves

and more attention should be paid to formulating rumen-friendly starter concentrates.

Key Words: Calves, Concentrate, Ruminal fermentation

W205 Delayed introduction of a low-starch concentrate induces normal ruminal development in dairy calves at weaning. N. B. Kristensen*, J. Sehested, S. K. Jensen, and M. Vestergaard, *Danish Institute of Agricultural Sciences*, *Tjele, Denmark*.

Traditional starch-rich concentrates for milk-fed calves induces an acidotic ruminal environment even with small daily intakes. A new feeding regimen including use of low-starch concentrate was formulated and tested for impact on ruminal environment and -development in 2 to 10 wk old calves. Eight Holstein calves (48 ± 1 kg BW at birth) implanted with ruminal cannulaes (20 mm ID) at d 7 ± 1 of age were allocated to one of two feeding regimens. Calves on control treatment (CON) had free access to a barley-based concentrate (319 g starch/kg) from wk 1. Calves on alternative treatment (ALT) had no access to concentrate until wk 4 when they got free access to a low-starch concentrate (68 g starch/kg). All calves had free access to artificially-dried grass hay, and water and were fed skim-milk-based milk-replacer (4.6 L/d in wk 1 to 2, 6.4 L/d in wk 2 to 7, and 3.2 L/d in wk 7 to 8). Every wk, 8 ruminal samples/calf were collected from 0730 to 2400. There were no treatment effects on ADG (802 ± 35 g/d) or total solid feed DMI (concentrate + hay; 78 ± 4 kg). On ALT compared with CON, average ruminal pH was higher (6.39 vs. 6.04 ± 0.09, P < 0.05) and minimum ruminal pH was higher (6.14 vs. 5.57 ± 0.09, P < 0.01). A relatively large treatment x wk interaction was found for all VFA data. Especially from wk 2 to 4 the butyrate profile and the ruminal butyrate concentration was smaller (P < 0.001) for ALT (1 to 3 ± 1 mmol/L) compared with CON (6 to 9 ± 1 mmol/L). However, when concentrate was introduced to ALT calves ruminal butyrate increased to a higher (P < 0.001) level (12 to 19 ± 1 mmol/L) compared with CON (8 to 13 ± 1 mmol/L). No differences between treatments in ruminal mass, length, shape and aggregation of ruminal papillae were detected at wk 10. Our results show that it is possible to formulate rumen-friendly low-starch concentrates without compromising growth or ruminal development in milk-fed calves.

Key Words: Calves, Concentrate, Ruminal fermentation

W206 Performance of dairy heifer calves fed milk replacers with equal protein and fat levels but utilizing different fat sources. B. Braman*[1], S. Hayes[1], H. Chester-Jones[2], D. Ziegler[2], J. Linn[3], and B. Ziegler[4], [1]*Milk Products*, *Chilton, WI*, [2]*University of Minnesota*, *Waseca*, [3]*University of Minnesota*, *St. Paul*, [4]*Hubbard Feeds*, *Mankato, MN*.

One-hundred-eleven 2 day-old dairy heifer calves (BW 41.8 kg ± 0.54 kg) were randomly assigned to one of 3 all-milk protein milk replacer (MR) treatments to evaluate the effect of fat source on pre- and post weaning calf performance. All MR contained 24% protein: 20% fat and only differed by fat source. Fat treatments were: 1) Animal fat (AF); 2) Vegetable blend of 80% palm oil and 20% coconut oil (VF); and, 3) AF plus a blend of medium chain tri-glycerides containing 1% caproic, 69% caprylic, 1% capric and 29% lauric acids fed at 5 g/calf daily (AFA). Milk replacers were fed at 0.28 kg (as-fed) in 1.99 L water 2X daily for the first 35 days, and then 1X daily from day 36 to weaning at 42 d. Calves were offered an 20.9% CP (DM basis) texturized calf starter throughout the study. Fresh water was available daily at all times. Total DMI from MR for 42 d averaged 20.9 kg/calf. Feed DMI to 42 d tended to be higher for calves fed AF (26.38 kg) vs. those fed AFA (23.95 kg; P <.08) with the VF calves being similar to other groups (24.19 kg). Daily gains to 42-d were similar (P > 0.05) averaging 0.65, 0.62 and 0.62 kg for calves fed AF, VF, and AFA, respectively. There were no differences (P > .05) in post weaning gain and gain/feed from d 42 to 56, which averaged 0.95, 0.45; 0.95, 0.47; 0.96 and 0.47 kg for calves in the AF, VF and AFA groups respectively. Overall 56-d daily gain and gain/feed were not affected by treatments (P >.05) averaging 0.73, 0.53; 0.70, 0.54; 0.70 and 0.54 kg for calves fed AF, VF, and AFA, respectively. Fecal scores taken daily throughout the study were not affected by treatment (P > .05). Under the conditions of this study feeding a common milk replacer with varying fat sources did not affect pre- and immediate post weaning calf performance.

Key Words: Dairy calves, Milk replacer fat sources, Performance

W207 Pre- and post weaning performance of dairy heifer calves fed texturized or pelleted calf starters with or without intake enhancing flavors. B. Ziegler*[1], R. Larson[1], H. Chester-Jones[2], D. Ziegler[2], J. Linn[3], and S. Hayes[4], [1]*Hubbard Feeds*, *Mankato, MN*, [2]*University of Minnesota*, *Waseca*, [3]*University of Minnesota*, *St. Paul*, [4]*Milk Products*, *Chilton, WI*.

One-hundred-fourteen 2 day-old dairy heifer calves (av. BW 40.6 ± 0.77 kg) were randomly assigned to one of 5 calf starter (CS) treatments (av. CP 21.4% DM basis) to evaluate DMI and pre- and post weaning calf performance. Calves were housed in 2.29 x 1.17 m individual calf pens within a frame-steel curtain side-wall naturally ventilated calf barn. Treatments were: 1), texturized control (TCS); 2), pelleted control (PCS); 3), PCS with chocolate flavor (PCSC); 4), PCS with whey flavor (PCSW); and, 5), PCS with sweet start flavor (PCSS). Calf starters were offered free choice throughout the study. All calves were fed a medicated 20% protein:20% fat milk replacer in two equal feedings at 0.28 kg (as-fed) plus 1.99 L water for 35 d and once a day from 36 d to weaning at 42 d. Fresh water was available at all times. Pre-weaning 42 d ADG was higher (P <.01) for calves fed TCS than calves fed PCSS (0.62 vs. 0.49 kg). Daily pre-weaning gain for calves fed PCS (0.57 kg), PCSC (0.55 kg), and PCSW (0.56 kg) were intermediate. Pre-weaning CS DMI was not different between treatments, however, calves fed PCSS tended (P <.09) to eat less than calves on the other treatments. Post weaning DMI and ADG from 43-56 d were lowest (P <.02) for calves fed PCSS. Overall 56-d DMI, CS intake and total gain were lowest (P <.04) for calves fed PCSS. Gain/feed was highest (P <.01) for calves fed TCS. Average daily gain and gain/feed for 56-d were 0.70, 0.56; 0.64, 0.50; 0.65, 0.52; 0.63, 0.51; 0.53 and 0.48 kg for calves fed TCS, PCS, PCSC, PCSW, and PCSS, respectively. Under conditions of this study heifer calves tended to utilize a texturized CS more effectively than those fed pelleted starters. The addition of flavors to PCS did not improve calf performance and in the case of PCSS was detrimental to calf growth.

Key Words: Dairy calves, Calf starters, Performance

W208 Performance of Holstein dairy heifers fed concentrate diets containing dried distillers grains or urea. R. Larson*[1], B. Ziegler[1], J. Linn[2], D. Ziegler[3], and H. Chester-Jones[3], [1]*Hubbard Feeds*, *Mankato, MN*, [2]*University of Minnestota*, *St.Paul*, [3]*University of Minnesota*, *Waseca*.

Ninety Holstein dairy heifers (av. BW 100.9 ± 1.30 kg) were used in an 84-d study to evaluate feed intake and performance from 13 to

24 weeks of-age. Post weaned heifers were randomly assigned to 5 replicate pens (6 heifers/pen) each of 3 grower diets containing an 18% CP (DM basis) concentrate mix limit-fed up to 2.27 kg/heifer daily with free-choice hay. Concentrate mixes were: 1), Cracked-corn and soybean meal-based pellet (C); 2), Cracked corn and dried distillers grain (DG; 1.45 kg DG/heifer; CDG) and 3), Cracked-corn and urea-based pellet (22.7 g urea/heifer; CUP). During the first 28 d of the study, heifers fed CDG tended to have (P <.10) faster daily gains (0.93 kg) than those fed CUP (0.85 kg) but similar (P >.10) to those fed C (0.87 kg). Gain/feed for the same period was similar across heifer groups (P > 0.2) averaging 0.27 kg. There were no heifer performance differences (P > 0.2) from d 29 to 56 or 57 to 84 d. Final BW and body condition score were 181.05 kg, 3.68; 184.65 kg, 3.68; 180.18 kg and 3.72 for heifers fed C, CDG, and CUP diets, respectively. Overall heifer performance for the 84 d study was not affected by concentrate mix fed (P > 0.3). Average daily hay intake was 2.42 kg/heifer over 84 d with a range from 1.41 kg/heifer during d 1 to 28 up to 3.46 kg/heifer from 57 to 84 d. Total gain, total DMI and gain/feed for 84 d were, 79.68, 355.45, 0.23; 83.15, 346.85, 0.24; 80.27, 346.39, and 0.23 kg/heifer for those fed C, CDG, and CUP diets, respectively. The study found that limit feeding a concentrate mix to 2.27 kg/ day with free choice hay for post weaned dairy heifers from 13 to 24 weeks of age supported good growth rates. Using DG or urea as alternative protein sources in concentrate mixes were acceptable options.

Key Words: Dairy heifers, Distillers grains and urea, Performance

W209 Performance of Holstein dairy heifers full vs. limit fed whole-shelled corn and protein pellet diets with differing fiber levels. H. Chester-Jones*[1], D. Ziegler[1], R. Larson[2], B. Ziegler[2], and J. Linn[3], [1]*University of Minnesota*, *Waseca*, [2]*Hubbard Feeds*, *Mankato, MN*, [3]*University of Minnesota*, *St. Paul*.

Ninety-six dairy heifers were used in a 112-d study to evaluate feed intake and performance from 9 to 25 weeks of-age. Heifers (av. 93.0 ± 1.76 kg BW) were randomly assigned to 1 of 4 grower diets; 6 heifers/pen, 4 pens/treatment. Treatments were: 1), 16% CP whole-corn (WC) and pellet (P) mix (6.5% ADF) limit-fed to 2.72 kg/calf (as-fed) for 84-d and to 2.27 kg/calf daily from 85 to 112 d with a 20.9% CP free-choice (FC) alfalfa hay (WCP); 2), 18% CP WCP mix full-fed (FF) to 84-d with no hay and up to 2.27 kg/calf daily with FC hay from 85 to 112d (PFC); 3), 18% CP higher fiber WCP (11.3% ADF) FF to 84-d with no hay and limit fed with FC hay from 85 to112 d (PHF) and 4), 18% CP lower fiber WCP (6.5% ADF) FF as in 2 (PLF). For the period 1 to 84-d, heifers fed WCP (av. 2.32 kg hay/heifer daily) had the lowest (P <.01) daily gain (1.04 kg) and gain/feed (0.23 kg) vs. FF diets, which averaged 1.26 kg and 0.28 kg, respectively. From d 85 to 112, heifers fed WCP had the highest (P <.01) DMI and greater ADG (0.97 kg; P <.03) compared to those fed PFC (0.70 kg) and PLF (0.64 kg) with PHF heifers being intermediate (0.83 kg). Final BW (230.81 kg) and BCS (3.72) for WCP heifers were 5.3% and 6. 1% lower than the other heifer groups, respectively. Total gain over 112-d for WCP heifers (114.78 kg) was lower (P < .03) than PFC (126.69 kg) and PHF (128.21 kg), and tended to be lower (P <.09) than PLF (123.43 kg) heifers. Daily gain and gain/feed for the 112-d study were 1.03, 0.21; 1.13, 0.25; 1.15, 0.25; 1.10 and 0.22 kg for WCP, PFC, PHF, and PLF, respectively. The study indicated that limit-feeding concentrate grower diets with access to FC hay in group pens from 9 to 25 weeks of-age resulted in a more consistent heifer performance when compared to FF concentrates without hay followed by a period of limit feeding concentrates with FC hay.

Key Words: Dairy heifers, Full vs. limit-fed concentrates, Performance

W210 Rumen fermentation patterns of dairy heifers fed restricted amounts of high and low forage diets. M. L. Moody*, G. I. Zanton, and A. J. Heinrichs, *Pennsylvania State University*, *University Park*.

Feed costs are the largest single component of a dairy heifer enterprise and need to be optimized in relation to maintaining satisfactory growth rates while maximizing feed efficiency. Normally, high forage (HF) diets are fed to dairy heifers for *ad libitum* consumption. Alternatively, low forage (LF) diets can be fed at restricted intakes to reach optimal ADG that maximize the nutritional efficiency of growing dairy heifers while minimizing costs. The objective of this experiment was to investigate the rumen fermentation of diets with differing forage:concentrate ratios with corn silage (CS) as the sole forage source. A HF TMR, (77% CS, 23% grain; 10.8% CP, 40.5% NDF) and a LF TMR, (67% grain, 33% CS; 12.3% CP, 38.3% NDF) were fed to 4 rumen cannulated Holstein heifers (BW 298 ± 16 kg) in a crossover design for two 21d periods. The treatment rations were fed on a restricted basis to provide 0.21 Mcal ME intake per kg $EBW^{0.75}$. Actual N intake was 105.9 HF and 114.0 LF ± 0.7g (P<0.02). Rumen contents were sampled on d19, removed on d21 and *in situ* determinations were made on d15-21 on CS and treatment rations. Low forage rations resulted in an increased rate of *in situ* digestion when compared to HF (4.4 LF vs. 2.2 HF ± 0.3%/h; P<0.04), but no differences were observed in CS digestibility. Mean rumen pH tended to be lower for LF (5.9 LF vs. 6.2 HF ± 0.06; P<0.07). Total VFA concentrations were not different between treatments (139.8 LF and 126.4 HF ± 5.8 mM; P>0.2) nor were the concentrations of acetic, propionic, or butyric acids altered between treatments (all P>0.1). Mean rumen ammonia concentration was not different between treatments (5.9 LF vs. 4.3 HF ± 0.5 mg%; P>0.1). Total rumen contents, both wet and dry amounts, were lower for LF (P<0.05). We determined that feeding LF rations at restricted intakes to growing dairy heifers, while more rapidly digestible, results in minimal changes in rumen fermentation patterns.

Key Words: Forage:concentrate, Dairy heifers, Rumen fermentation

W211 The effects of restricted feeding a high concentrate or high forage ration for similar weight gains on structural growth in Holstein heifers. G. I. Zanton* and A. J. Heinrichs, *The Pennsylvania State University*, *University Park*.

Forages typically compose most of the ration that is fed to growing dairy heifers as opposed to concentrates. However, there is a large inefficiency associated with this method of feeding due to lower digestibility of most forages, greater metabolic protein and energy requirements associated with digesting forage, and higher feed costs per unit of energy as compared to concentrates. The physiological potential exists to replace a significant proportion of the forage DM in a ration with concentrate DM, reducing the inefficiency associated with raising dairy heifers while maintaining similar ADG. The objective of this experiment was to evaluate heifer growth characteristics when given a high concentrate (**HC**) or a high forage (**HF**) ration at restricted intakes to achieve a similar ADG. Both the HC and the HF rations contained the same ingredients, but in differing proportions, yielding two treatment rations containing 75 or 25 percent of the ration dry matter as forages (grass haylage and corn silage). Treatment rations were delivered individually in a TMR twice daily to 21 heifers per

treatment for similar levels of ADG for 35 weeks. Body weights and structural measurements were taken twice weekly and gains were computed as the linear regression of the measured value of interest against the days on trial. Initial (142 kg ± 5) and final BW (343 kg ± 5) were not different between treatments (P>0.20) and ADG were similar between treatments (822 HC vs. 830 HF g/d ± 10; P>0.20). Less DM was consumed by the heifers fed HC than for HF (5.41 HC vs. 5.95 HF kg/d ± 0.11; P<0.01) at similar ADG leading to significantly improved feed efficiency for the heifers receiving HC (P<0.01).Daily gains of skeletal measurements were not different between treatments. Reproduction and first lactation data are also being monitored. From these results we conclude that feeding a HC ration leads to similar growth performance when the level of intake is restricted to achieve a controlled ADG.

Key Words: Dairy heifers, Forage:concentrate, Growth

Ruminant Nutrition: Feedstuff Digestibility & Nutritive Value

W212 Prediction of the nutritive value of maize stover using near infrared reflectance spectroscopy. S. Fernandez-Rivera*, G. Gebremariam, J. Hanson, and D. Negassa, *International Livestock Research Institute*, *Addis Ababa, Ethiopia.*

Our objective was to develop equations to calibrate near infrared reflectance spectroscopy (NIRS) instruments for predicting the nutritive value of maize stover. Two maize cultivars were grown in three replicates in one location in 2001, two cultivars in 12 farms in four locations in 2001 and eight cultivars in three replicates in one location in 2003. Stem, blade, husk and husk-less stover samples were taken at silk, dent and mature stages and analyzed for DM, OM, CP, NDF, ADF, ADL, true in vitro OM (TIVOMD) and NDF (NDFD) disappearance. They were scanned in a FOSS NIR System Model 5000 and absorbance was determined from 1100 to 2498 nm at intervals of 2 nm. Calibration results from principal component analyses using a mathematical treatment 1, 4, 4, 1 are presented in Table 1. Prediction equations were validated using an independent set of samples with n=232, 232, 231, 112, 48, 186 and 186 for OM, CP, NDF, ADF, ADL, TIVOMD and NDFD, respectively. Validation R^2 and SE of predictions were 0.98 and 0.61 for OM, 0.98 and 0.29 for CP, 0.89 and 3.93 for NDF, 0.94 and 1.78 for ADF, 0.87 and 0.62 for ADL, 0.86 and 3.10 for TIVOMD and 0.85 and 4.35 for NDFD. The NIRS equations developed can be used to predict the nutritive value of maize stover with acceptable levels of precision, but the precision is lower for NDF and NDFD than for OM, CP, ADF, ADL and TIVOMD.

Table 1.

Parameter	OM	CP	NDF	ADF	ADL	TIVOMD	NDFD
n	447	454	453	223	94	349	351
SEC	0.49	0.29	3.15	1.54	0.46	2.60	4.31
R^2	0.99	0.99	0.93	0.98	0.94	0.90	0.86
SECV	0.56	0.33	3.51	1.92	0.53	0.88	4.75

SEC=SE of calibration, SECV=SE of cross-validation

Key Words: Crop residues, Maize, NIRS

W213 Estimation of the nutritive value of cereals and wheat by products with or without oregano and rosemary supplementation. A. Caputi Jambrenghi[1], F. Giannico*[1], M. A. Colonna[1], C. A. Marano[1], L. Marvulli[1], G. Cappiello[2], and G. Vonghia[1], [1]*University of Bari*, *Bari, Italy*, [2]*Breeder Association of Taranto*, *Taranto, Italy*.

Durum wheat is mainly imported in South Italy despite its production in the Apulian region. The new EU Common Agricultural Policy provides the same subsidy for any crop which respects good economic and environmental conditions; hence the identification of crop systems which give a better yield and the choice to grow soft wheat and barley. Herbs and natural extracts typical of the Mediterranean area like oregano and rosemary act as antimicrobials, antioxidants and immunostimulators but their effects on rumen fermentation have been little investigated. The aim of the study was to evaluate the effect of sun dried oregano (OR) and rosemary (RO) (10 g/kg feed) on the nutritive value of local cereals (soft and durum wheat, barley, triticale) and derivatives from flour-milling (wheat middlings and bran). In vitro gas production was assessed by the Menke and Steingass (1988) technique, checked until 72 h and expressed as ml/g DM. The metabolizable energy (ME; MJ/kg DM) was calculated as: 1.06 + 0.157GP + 0.084CP + 0.22CF - 0.081CA, where GP is 24 h net gas production (ml/g DM), CP, CF and CA are crude protein, fat and ash (% DM), respectively. Data were processed by ANOVA according to a 6 (n. of feeds tested) x 3 (control, OR or RO supplementation) experimental model. Student's t test was used to compare differences between means. OR increased soft wheat (P<0.01) and wheat middlings (P<0.05) GP. The GP of barley was significantly depressed by OR and RO (P<0.01). The ME values showed the same trend: OR improved the ME of soft wheat (P<0.01) and of wheat middlings (P<0.05), while OR and RO markedly decreased the ME of barley (P<0.01). Durum wheat, triticale and wheat bran were not influenced by the herb supplementation. In conclusion, OR and RO affect rumen fermentation, but their effect on the activity of cellulolytic and amylolytic bacteria needs further study.

Key Words: Cereals and wheat by products, Nutraceutics, In vitro gas production

W214 Nutritive evaluation of different types of frost damaged wheat for ruminants: I. Chemical characterization, II. energy values, III. protein and carbohydrate subfractions, IV. rumen degradation kinetics, and V. modeling nutrient supply. P. Yu*, V. Racz, L. White, J. J. McKinnon, and D. A. Christensen, *University of Saskatchewan*, *Saskatoon, SK, Canada*.

In 2004, more than 50% of wheat was frost damaged (frozen) in Canada resulting in millions of tons of frozen wheat. There is an urgent need to fully evaluate the nutritive value of frozen wheat for ruminants. The objectives were to compare chemical characterization, rumen digestive behavior, and potential nutrient supply to ruminant animals between normal wheat and different types of frozen grain wheat. Results showed that the frozen wheat was lower in starch, non-structural CHO, NPN and higher in crude fat, ADF and NDF, lignin, ADIN and NDIN. The frozen wheat was lower TDN and energy values (DE3X, ME3X, NEL3X for dairy; ME, NEm, and NEg beef cattle). Partitioning protein and carbohydrate (CHO) fractions showed that the frozen wheat